BELLCOMM, INC.

SUBJECT: NASA/NAA Program Management Review and CSM 017 Customer Acceptance Readiness Review - Case 330

DATE: December 23, 1966

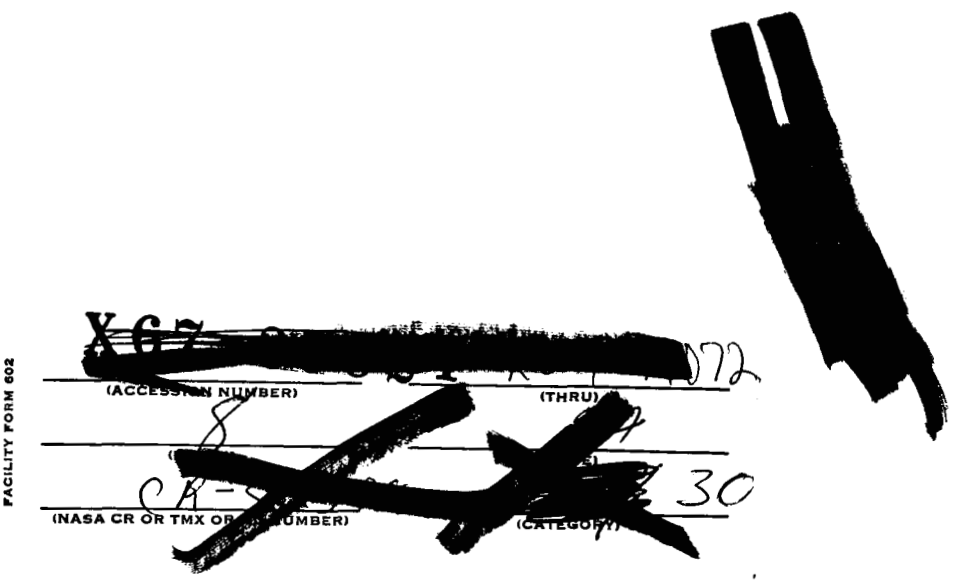
FROM: P. F. Sennewald

ABSTRACT

A Program Management Review and the Customer Acceptance Readiness Review for CSM 017 was held at North American Aviation on December 13 and 14. Significant technical problems from the meetings are summarized in this memorandum.

Thrust vector control stability of the Block II CSM - with and without the LM - appears to be marginal. The CSM is experiencing significant relay contamination problems which can impact CSM's 012 and 017. Transistor failures continue to plague the Electrical Power System inverters. A revised acceptance test plan for the Environmental Control System is being implemented which will result in better tests at AiResearch.

The CSM 017 will be shipped without the Mission Control Programmer because of contaminated relays. The SM Reaction Control System has been found to have contaminated check valves; the CM will be held at NAA to check the CM RCS check valves. This problem can affect all CSM's through 102.



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MEMORANDUM FOR FILE

1.0 Introduction

The author attended the NASA/NAA Program Management Review at Downey, December 13, and the CSM 017 Customer Acceptance Readiness Review (CARR), also at Downey, on December 14. This memorandum provides a review of the material presented at these two meetings.*

2.0 NASA/NAA Program Management Review

The following is a summary of all the items discussed.

2.1 Block II Thrust Vector Control Stability

CSM 009 experience** and several sets of two dimensional bending mode data indicate that the stability margins for the SCS ΔV control modes for both the CSM and CSM-LM configurations may be inadequate. Design changes have not been made by NAA in anticipation of the results of a three dimensional bending mode analysis by TRW, nor has the feasibility of any alternate approaches been assessed.

Dr. Shea expressed the view that control loops were being designed to be tighter than necessary thus aggravating stability problems. MSC will review and advise NAA.

2.2 Relay Problems

Significant problems exist with contamination due to a polymer coating on relay contacts (in the pyro continuity verification box) and with "solder balls" (in the Mission Control Programmer MCP).

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*T. L. Powers also attended the Management Review and has issued an earlier memorandum titled CSM Program Management Meeting on December 15.

**One of the bases for concern was the 17 cps instability evidenced by CSM 009 in the stack at KSC which was fixed by the addition of a filter. It was noted that the instability did not appear in NAA checkout at Downey.

The solder balls are the more serious problem due to frequency of occurrence and criticality of some of the relays involved. The solder balls are caused by the soldering process required to "closeout" the evacuated relay cans; relays with welded closeouts are cleaner but unfortunately the use of these relays has not been consistent. The most immediate and potentially serious impact is in the CSM 017 MCP where some 35 of these relays are used, five of which perform critical functions.* The problem is complicated by the lack of a reliable detection technique; an x-ray technique is being evaluated. Disassembly of the relays is to be avoided if possible as this may destroy the circuit boards and spares are not available.

Elsewhere in the Block I CSM some 600 relays are used which may have been closed out with solder - almost 400 of these are in the G&N. It is known that CSM 012 contains some soldered relays.

To complete the relay problem list, contact troubles may develop due to stresses placed on the relay when installed. Clipping of the relay leads is known to stress the structure such that the contact area is reduced with the attendant increase in current densities. Failures have not occurred yet.

2.3 Reduction in Requirements for Corrosive Testing

NAA proposed significant reductions in CCOH (Corrosive Contaminants, Oxygen, Hydrogen) testing requirements (duration and temperature). MSC requested failure data to support the contention that reduced requirements will still permit detection of failures.

2.4 Reduction of NAA Reliability Efforts

NAA proposed a reduction primarily in failure reporting efforts which would cut their manpower in this area by about half. The data would still be available but not in the readily accessible form of magnetic tapes. MSC will review the proposal.

2.5 Inverter Failures

Additional transistor failures (one at KSC and one at Downey) have occurred. The problem appears to be one of quality control in fabrication. No known replacement transistor is available; the nearest known equivalent is too fast and causes inductive "kicks" which would require inverter redesign.

* Subsequent to the CSM 017 CARR, it has been learned that all the soldered relays in the MCP have been replaced.

A screening process has been used to keep suspect units out of spacecraft. However, CSM 017 has inverters with unscreened units which will be replaced with inverters from CSM 020. In any event, the screening process is known to be deficient.

Westinghouse has been authorized to initiate a backup transistor development program.

2.6 Caution and Warning System Failures

This system is still giving Master Alarm signals on transients without providing alarms in the subsystem channel. (The same problem will exist in Block II.) NAA will provide a current report of recent failures.

2.7 ECS Failure Report Results

A number of recent ECS failures were satisfactorily explained. One exception was the blockage of the urine dump nozzle in the second manned test of CSM 008. The results of a chemical analysis indicated large amounts of aluminum oxide and aluminum hydroxide which appear inconsistent with earlier reports that the blockage was due to urine salts.

2.8 CSM 101 Task Team

NAA has initiated a special effort to expedite the CSM 101 schedule to meet the recently revised flight mission schedule. As a part of this, they proposed taking advantage of the fact that the mission requirements for this spacecraft are reduced as compared to CSM 103, e.g.:

(a) earth orbital vs lunar mission

(b) uprated Saturn I vs Saturn V launch

(c) abort water landings vs land abort landings, and

(d) short range communication requirements.

In other words, Block II changes required for LOR missions could be eliminated on CSM 101 in order to expedite the schedule.

MSC discouraged this philosophy and it was concluded that such a policy would not be formally adopted. However, Messrs. Shea, Lanzkron, Myers and Kehlet will consider these criteria in reviewing changes for CSM 101.

NAA will also present a revised checkout philosophy on CSM 101 early in January with the objective of schedule improvement.

2.9 Revised ECS Acceptance Test Plan

NAA is implementing a revised test plan for the ECS and its components both at NAA and at AiResearch. Systems tests at NAA will not be relied upon for component tests; AiResearch will perform more component tests including a complete, wet functional test of the Environmental Control Unit.

It was also reported that a ΔCDR of the Block II ECS will be held at AiResearch on January 3, 1967.

3.0 CSM 017 CARR

The following is a summary of the significant items reported. Some are simply referenced to the Management Review discussed above. Major General S. C. Phillips and Brigadier General C. H. Bolender attended this meeting.

3.1 Electrical Power System

Requirements for bus modulation levels will be changed since most of the noise occurs above 90 cps where it is less troublesome. Levels of 0.75% up to 90 cps will be required (same as before) while levels up to 4% will be permitted above 90 cps (was 0.75%).

The -1 inverter will be replaced with a -4 inverter from CSM 020 (see paragraph 2.5) before shipment.

3.2 Fuel Cells and Cryogenic Systems

No major problems were reported. However, Dr. Shea emphasized the need to review and re-review all fuel cell procedures since this is the first exposure to Launch Complex 39 and it is important to minimize any further fuel cell losses.

3.3 Environmental Control System

Due to the single point failure criticality of the glycol evaporator (water boiler) on CSM 017,* the unit will be subjected to a complete functional test at KSC to ensure that the evaporator control loop is functioning properly. MSC will determine if the back pressure control can be set in one position for the entire mission to further simplify the control function for this mission. The KSC test will reflect this determination.

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*The ECS radiators on the SM are not connected on CSM's 017 and 020.

3.4 Communications System

The unified S-Band equipment is at Motorola for minor modifications; it will be reinstalled at KSC.

3.5 Instrumentation

All but three measurements have been verified and are working. This is some sort of a record.

3.6 Reaction Control Systems

Quad B of the SM RCS was found to have a contaminated check valve. Discussion revealed the existence of a potentially serious problem in all spacecraft up through CSM 102, in both the CM and SM RCS's. It appears that it originates with the valve vendor. The problem is aggravated by the lack of good contamination detection techniques; a functional check of the valve is the best available method. Disassembly for inspection introduces still more contamination.

Shipment of CM 017 will be delayed one to two days for functional checks at NAA of the CM RCS valves since they have not been checked for six months.

3.7 Service Propulsion System

A complete review of the CSM 017 tank history and the rationale for their use was deferred to the Management Council Meeting in Washington on December 21, 1966, where the action items from the AS-204 DCR will be reviewed. The fuel storage tank in 017 came from CSM 001 and has had some limited methanol exposure. The fuel sump tank is a tank that has been previously damaged (partially collapsed) and repaired (re-inflated) and has not seen methanol. Both tanks have recently been held at 240 psi for 48 hours and then proof tested at 275 psi.

A proposal was made - and disapproved - to operate the SPS tanks at Block II pressure (212 psi vs. 240 psi for Block I) using Block II relief valves in order to reduce tank stresses.

The SPS gimbal actuators were replaced with flight actuators at Downey. Recently, the pitch actuator was activated for unexplained reasons for 18 minutes.

3.8 Stabilization and Control System

Failures of 12 "Golden G" relays in Block II and four in Block I have given rise to concern about possibility of additional failures. This is being investigated.

3.9 Guidance and Navigation

The capacitors associated with the Pulse Integrating Pendulous Accelerometers in the inertial unit have failed (opens and shorts) in Block II. A thermal screening test has been developed and will be applied to CSM 017. Applicability to CSM 012 was not mentioned.*

3.10 Sequential Events Control System

The spacecraft will be shipped without the Mission Control Programmer due to the solder ball contamination problems described in paragraph 2.2. If a significant number of the MCP relays are contaminated or if they have to be opened for contamination assessment, the impact can be serious since spare boards with relays are not available.

The SECS also has a transistor failure problem in the SM separation timer which is not yet understood.

3.11 Earth Recovery System and Ordnance

No major problems were reported.

3.12 Structures and Mechanical Devices

Due to a recent failure in the sway brace in the SM in tests of CSM 252, a new design has been implemented on CSM 012 and subs.

3.13 Displays and Controls

No major problems were reported.

P. F. Sennewald

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*W. Levidow reports that the CSM 012 IMU has already had this thermal screening test applied without failure. These capacitors in CSM 020 have been replaced.

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